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BOOK REVIEWS

Quantum Mechanics (Symbolism of Atomic Measurements) – Julian Schwinger

Edited by Berthold-Georg Englert

Springer . Berlin-Heidelberg-New York-Barcelona-Hong Kong-London-Milan-Paris-Singapore-Tokyo (2001)

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Like many other famous textbooks, the present volume has its roots in the university classrooms Julian Schwinger taught quantum mechanics at Harvard University in the 50's and again at UCLA in the mid 80's. This book is primarily based on the UCLA lecture notes, which were compiled and organized after Schwinger's death by his collaborator, Berthold-Georg Englert As mentioned in the preface by the editor, the experiences of the author at Harvard and the innovations he made there in the presentation of the subject matter, have been incorporated and fully integrated in this text

The Schwinger lectures were aimed at students already exposed to basic undergraduate level quantum mechanics and to some extent familiar with the solution of elementary wave mechanical problems. Thus, the lectures directly delve deeper into the powerful formal structure of quantum mechanics and its physical implications to cover more advanced grounds.

In the beginning, the editor has added an important material in the form of a prologue, based on a public lecture by Schwinger in the early 60's. Here, the conceptual basis of quantum mechanics has been presented in a concise but very comprehensive way. This is one of the best treatments of the philosophy of quantum mechanics, which I have come across. This article, I believe, would be accessible to a wide range of audience, and not only to those who might be interested in the course material as such. Starting with the causal but non-deterministic nature of quantum theory, Schwinger goes on to discuss the peculiarities involved in quantum measurement, and stresses how they imply a decisive break with the concept of classical measurements. The state functions provide a framework only within which quantum measurements and their outcomes can be interpreted, This position explains the choice of the subtitle 'Symbolism of atomic measurements'. In this context, Bohr's Principle of Complementarity emerges as the statement about a new world in terms of two classical analogies, mutually exclusive and applicable in different circumstances. In the final part of the article, Schwinger discusses the collapse of another philosophical basis of classical physics, that of the distinguishability of particles. The multiparticle state functions embedding this concept of indistinguishability must be thought of as vectors in an abstract space and the zero-particle state function becomes a perfectly legitimate vacuum state In the mathematical scheme, creation and annihilation operators enter as real physical objects. We have, through these operators, the concept of quantized field, unifying and transcending the contradictory classical concepts of the discreteness of particles and continuity of a field. In the end, Schwinger summarizes the still ongoing philosophical debate about the possible existence of a level of reality where particles and their interactions might be understood in terms of things that are not directly observable (as the underlying quantized fields are).

The development of the quantum mechanical formalism in the main body of the book follows the conceptual trajectory of this lecture. It is divided into three parts corresponding to the three teaching quarters through which the course continued. The three parts have the titles 'Quantum kinematics', 'Quantum dynamics' and 'Interacting particles' respectively.

In the first part, the basic properties of quantum measurements are introduced through the analysis of the results of a Stern-Gerlach type experiment. We may recall that in the 60's, another great theoretical physicist, and, incidentally, one of the co-founders of QED, Richard Feynman, in his lectures, used the same experiment to introduce the quantum concepts of probability amplitudes, their superposition and the inevitable disturbance of state due to measurement in general. However, as mentioned earlier, this course quickly moves to more advanced topics. The concept of unitarity and unitary transformations are introduced through the two valued magnetic moment of the Stern-Gerlach experiments, and then generalized to unitary operators with more than two base states. The transition to the continuum limit is shown, and in this limit, Heisenberg's commutation relation follows from the properties of unitary operators. Link with Schrödinger's wave mechanical formulation is established by converting the vector equations of the unitary transformation to numerical form in the co-ordinate basis The establishment of the continuum limit also leads to the introduction of the wave functions in the q and p spaces through standard routes. The properties of the basis states of the q representation, the δ-function, are derived in great detail, and the minimum uncertainty states are obtained in standard fashion. An interesting result, derived at this point, demonstrates that the states for which the uncertainty is neither a maximum nor a minimum but stationary, belongs to the complete set of Hermite-Gauss wave functions. Also, coherent states are introduced at this point as eigenstates of a non-Hermitian operator. They are also minimal uncertainty states with a well-defined classical limit in which the relative dispersion of the phase space volume approaches zero. The third chapter of the first part treats the algebra of angular momentum in depth. The last chapter of this part starts with the invariance of a physical system under rotations, translations and time displacement. The conservation laws arising from these invariances yield the non-relativistic Hamiltonian.

Part B, corresponding to the second quarter, is concerned with quantum dynamics, *i.e.*, the behaviour and evolution of quantum systems in various realistic situations. The starting point of these investigations is the derivation of the Heisenberg and Schrödinger's equations of motion from the unitary transformation corresponding to infinitesimal time displacement. The Quantum Action Principle follows from these equations. The rest of the book can be considered to be various applications of this Action Principle to in solving physical problems. The dynamical properties of the quantal free particle, the harmonic oscillator and the particle in a constant force field have been solved, with indication of the mathematical details in the derivations. The other instructive applications of the Action Principle discussed in considerable detail in part B are the driven harmonic oscillator and the hydrogen atom in external electric and magnetic fields.

The final part (Part C) starts with the two-particle Coulomb problem (scattering and perturbation of the two-particle system), which, in a sense, is a continuation of the treatment of the dynamics of the H atom in the previous part However, Rutherford scattering and its modification due to the presence of additional short range forces are also treated, and the implication of quantal indistinguishability has been introduced through scattering formalism in the usual way. The treatment of systems with many identical particles follow, leading to the concept of many particle states, the dynamics of creation and annihilation operators, and operator fields, paving the way for an elegant introduction to the basics of nonrelativistic QED by application of these methods. But before going to the electromagnetic field, a chapter has been devoted to illustrate some of the consequences of indistinguishability through a detailed treatment of the Hartree-Fock formalism and the Thomas Fermi model of atomic structure. The Thomas-Fermi model has been shown to be an approximate and semiclassical version of Hartree's approach. In the final chapter, the Quantum Action Principle has been applied to develop QED to the extent necessary for an understanding of the Lamb shift.

One of the major features of the book is the incorporation of a large number of problems, which both illustrate the basic principles presented in the lectures and sometimes extend or generalize these principles. In both ways, the contents of the problems are well integrated in the text and have become part of it. This has caused a rich and tight structure of the logical arguments. Let me give one example. In discussing the quantum correction to the Thomas-Fermi energy, reference is made to a problem, which asks the Thomas-Fermi energy to be shown as a semiclassical limit given by an integral in the classical phase space. Enough background material is given during the formulation of the problem so that it becomes easily understandable. In the same section we find that the quantum correction to the semiclassical phase space integral for one dimensional motion has been earlier given in the form of a problem. A three-dimensional generalization is then used for derivation of the required result. In some cases, application of the fundamental principles to concrete physical systems has been illustrated through the problems. The problems were all formulated by Schwinger himself. Most of them came with his lecture notes, though some have been recovered by the editor from Schwinger's research notes at the UCLA archive after his death.

In conclusion, it can be said that this is a text on the fundamentals of quantum mechanics from an advanced mathematical viewpoint, compiled from the notes of a great scientist and an extraordinary teacher. The lectures start by introducing the laws of motion in the quantum realm from a systematic analysis of experimental phenomena using a basically inductive approach. Next, the laws have been expressed in their full power and generality. This general formulation has been achieved by moving very systematically and carefully from one level of abstraction to the next. The mathematics used in the formulation of these abstractions and their applications to concrete physical situations, has been discussed in great detail. This approach finds its culmination in the treatment of the basics of QED in the last chapter.

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Electronic Absorption Spectroscopy and Related Techniques

by D N Sathyanarayana
University Press (India) Hyderabad, India and distributed by Orient Longman Ltd. (2001)
xvii + 532 pages, illustrated, price Rs 395 00 (Soft cover),
ISBN 81-7371-371-5

Although the various topics dealt with in the present book are available in separate volumes written by different authors, there was a long standing need to present these topics in a single, compact and almost self-sufficient volume well-knit in a systematic sequence and useful for self-study by the readers interested in electronic spectroscopy. The book fulfils this need and the author does so competently and fairly comprehensively. In the process, he has given lucid treatment in an easily understandable style, the various topics of electronic spectroscopy step by step starting from the fundamentals and has included some topics culled patiently from his experience in teaching and research. The reviewer is particularly happy to find excellent treatment of Frank-Condon principle, an important but often neglected topic. However, in the language of the author, no attempt has been made to present a comprehensive coverage of the enormous field of electronic spectroscopy and indeed, that would have adversely affected the volume of the book which has already attained a very large size. Thus, spectroscopy of not only $4d$ and $5d$ group ions but also some minor but interesting treatment in the case of $3d$ group ions have been excluded (*e.g.* the concept of effective P state in the ligand field level pattern, effective orbital Lande factor *etc.*).

Although the name of the book specifically refers to absorption spectroscopy, topics on emission have also been included. The book is broadly divided into two parts. Part I concentrates on topics needed for absorption spectroscopy and Part II on emission. In this division, some confusion may arise to the beginners, as for example, X-ray absorption spectroscopy has been included in the 'Emission' Part of the book, the reason should have been clarified to the reader. Further, in the opinion of the reviewer, chapters 1 and 2 of Part I dealing with the 'General introduction' and 'Atomic orbitals and states' should constitute a separate part which should be called Part I and should not come under either absorption or emission. These two chapters form the basis of atomic spectroscopy and are considered essential for the beginners. The author has very successfully presented them in an easily understandable manner. The remaining chapters (chapters 3 to 8) of Part I of the present book should form Part II and may come under 'Absorption'. The part II of the present book coming under 'Emission' should then be called Part III. Moreover, the reviewer considers that an outline of the method of calculation of energies of L-S terms in terms of Coulomb and exchange integrals and ultimately in terms of Condon and Shortley's F parameters should have been included in the chapter on 'Atomic orbitals and states'. No doubt, this would have added a few more pages but this would have considerably satisfied the logical and inquisitive readers.

In part I, the author's diligent endeavour to describe in an easy and clear style, the electronic spectra of both inorganic complexes and organic molecules, their assignment and intensity, and their origin and interpretation in terms of ligand field theory or molecular orbital theory or charge-transfer process as the case may be, is highly commendable. For the purpose, he has taken adequate care to equip the reader with the necessary mathematical and theoretical background before going to the actual spectroscopic problems.

The reviewer is also happy to find the logical but lucid and easily understandable presentation of Part II comprising chapters on Luminescence (Florescence and Phosphorescence), optical rotary dispersion and circular dichroism, photoelectron spectroscopy and brief review of advanced topics such as XANES and EXAFS and their applications. A very remarkable feature of this book is the inclusion of references and some relevant problems (to be solved by the readers) at the end of each chapter. The reviewer would have been happier if some hints were given for the solution of difficult problems and answers were quoted for mathematical questions.

On the whole, the book has a positive impact on all classes of readers, students, research workers and teachers. Post graduate and research students will be highly benefited by the author's style of presentation and the teachers will find the book to be of great help as a ready reference to the large number of topics of diverse nature, both classical and modern, of electronic spectroscopy, rarely found in a single volume.

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Computer, Internet and Multimedia Dictionary

by Surendra Verma
Universities Press (India) Limited . Hyderabad, India (1998)
viii + 228 pages, tables, illustrations, price : Rs 130 00 (Soft cover),
ISBN 81-7371-091-0

Computer, Internet and Multimedia Dictionary is a must for every computer user. It is equally useful for students, computer professionals as well as users who are novice to computer system. Everyday we are facing new computer jargons and it is practically impossible to be acquainted with all those new terms by consulting authentic text books. Now this book will certainly satisfy this need. The book is more than a traditional dictionary and explained in details many intrigues of computer, telecommunication and digital electronics related terms with sketches and diagrams whenever required. The sense of humor of author (when a computer catches cold *etc.*) added some sugar and spice to make it lucid. I could not find some of the popular terms (NIS, NFS, HUB, Network Switch, DNS, ISP, LINUX, Perl, Masquerade, netizen, ssh, UTP cable *etc.*) in the book. This type of book mainly on a constantly changing field needs regular updating and I hope we will get the updated version with wide coverage in near future.

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